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MANAGEMENT AUTOMATION OF CONSTRUCTION ORGANIZATION BASED ON BUILDING INFORMATION MODELING (BIM)

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Two information barriers were identified that influenced the phenomenon "organization management" as a process. As a result of the first barrier was a need to differentiate management functions by individuals. The second barrier was the impulse for the introduction of automation in the management of the organization. Initially, automation concerned only with the solution of local problems. Over time, automated control systems made it possible to integrate the activities of the entire organization. Building information modeling technology (BIM) currently allows you to take into account the increased flow of data on construction projects at all stages of the life cycle. There are significant differences in the construction process, which should be reflected in information management systems: product immobility, territorial disunity of the final product, the long duration of the production cycle, the diversity and interchangeability of the resources consumed, the multivariant nature of technological solutions, the difficulty of standard technology work, the difficulty of combining work, the influence of natural factors. The basis of management in construction is the "model of the object of management". One of the elements of this basic model is the project technological dependencies model (PTDM). This model allows increase the reliability of management decisions. The model is based on quantitative assessments of technological relationships between work.

Keywords: project technological dependencies model, PTDM, information management barriers, building information modeling, BIM, automated control systems, construction features.

Introduction

It is known that humanity development has crossed two informational barriers. The transition of the first barrier is characterized by the parallelization of management into activities (functions). This circumstance required the involvement of additional labor resources in the management sphere. Economic is constantly getting complicated and the number of people involved in this area is increasing. There are four main reasons for the complication of management:

1. A sharp increase in the product range. Each new type of product requires the solution of many management tasks.
2. The increasing complexity of the product itself.
3. The growing complexity of technology for producing products.
4. The complexity of managing the scientific and technical progress.

These reasons for the complexity of management lead not only to an increase in the solution of management tasks. This increase leads to a geometric progression growth of the amount of information that needs to be processed to make a decision. As a result, the number of people employed in management is growing rapidly.

Humanity crossed the second information barrier in the late 1940s and early 1950s. After this time no organizational or economic measures which were aimed at parallelizing management tasks could not and cannot provide a solution to all objectively necessary tasks. A further increase in the number of management staff could not give the desired effect. Instead of overcoming difficulties using management the oversized managerial staff began to work "for itself": coordinate its own activity. The growth of the managers can only be stopped by increasing labor productivity in the management area. The wide and active introduction of economic and mathematical methods, mathematical modeling, computer technology, modern methods of information processing, and others was facilitated the solution to this problem. The using of these modern methods was impossible without a quantitative assessment of the data that was necessary for solving management problems. Therefore, the "digitization" of the eco-

nomy is not a tribute to fashion, but this is a vital necessity. Today the ubiquitous applying of economic and mathematical methods and computer technology allows you to qualitatively transform the management sphere.

1. Automated control systems in the construction

In the USSR much attention was paid to the creation of automated control systems, in particular, in the construction. More details about development in the USSR from 1960 to 1990 the automated control systems in the construction can be found in the monograph [1]. The task of scheduling of construction works occupies a significant part of the functional in the automated control systems in the construction. This is the main problem that allows you to significantly influence the course of the main production in the construction company. The solution of other tasks affects only the local problems of production and economic activity of the company (for instance, optimization of arrangement of mechanisms, transportation management system (SUPER), optimization of inventories and others). The most famous and common computer program was the automated scheduling system A-PLAN. However, the effect obtained from the introduction of various automated systems in the construction did not reach the result that was expected of them. There were many reasons for this. They had a different nature: technical reasons, economic reasons, organizational reasons, methodological reasons, socio-psychological reasons, informational reasons and others. One of the important drawbacks of a socio-psychological nature was staff problem. When introducing into the company any tasks solved with the help of a computer, it was necessary to reduction in the number of management staff. This circumstance hindered the process of implementing automated systems. Moreover, during the transition of the Russian economy to the market economy, scientific research and practical work in this area were not conducted.

Currently, information modeling is actively being introduced into the construction industry [2, 3, 5–10]. The development of information technologies for modeling the construction of objects, as well as the stages of the life cycle of an object, can be correlated with the stages of design, construction, operation and reconstruction of the object. Their appearance also fluttered in accordance with these stages. Initially, the information model was used only for design purposes. In the future, information modeling began to perform tasks related to the construction and operation of the facility. On the example of the design stage, we can say that the development of automated technologies for the design of construction went through several stages: CAD-stage, BIM-stage.

CAD stage. It has been actively developing since the early 1980s. It essentially included the ability to select an object from the database (library of objects) and place them on a specific model space. Moreover, the software, which is believed to be one of the first to be developed for this type of task, (Building Description System, 1975) has never been used to design real objects. The first program used for building design was RUCAPS (Riyadh University Computer Aided Production System, 1980). It came with computers and cost, respectively, very expensive. Despite this, it was used, for example, for the design of Heathrow Airport in London. Subsequently, this program was transformed into Autocad, which is currently used for design in construction.

BIM stage. The first program, which basically used the BIM approach, that is, the possibility of not only designing, but also using an information model for construction purposes, was the ArchiCAD program (1984). Since 2000, the REVIT program has become very popular, which allows you to take into account the parametric dependencies of model objects between each other. To date, software for designers includes the possibility of parametric calculations, interactions between various modules of the model: for example, architectural structures, water supply, energy consumption, development of a calendar schedule.

The introduction of restrictions on the use of foreign software in Russia gives a serious impetus to the revival of interest among domestic developers of their own domestic software products that allow building information models of objects. Since 2015, the domestic development in the field of BIM – Renga has been developing. The software integrates the possibility of not only creating architectural projects, but also calculating design solutions, and automatically calculating estimates.

2. Key features of construction

Before talking about new opportunities in solving the tasks of scheduling construction works for automation of management, it is necessary to highlight various approaches to the development of automated control systems in the construction company and automated control systems in the industrial plant

[13–15]. This difference is based on the characteristics of the final product of construction production. They leave a certain imprint on the conditions of activity of construction organizations, since construction management is closely connected with the formalization of the processes of building and construction. There are 8 significant features.

The main difference between construction, as a branch of material production from other sectors, is immobility (1) and territorial disunity (2) of the final products of construction organizations: buildings and structures. The long duration of the production cycle (3) leads to a large volume of incomplete construction, an increase in working capital. The diversity and interchangeability (4) of consumed resources (material, machine and labor) leads to the emergence of many acceptable solutions for the technology of construction production and ways to perform work. The multivariance of technological solutions (5) is completely not typical for industrial production. The process of implementing projects in construction is not sufficiently normalized and described (6), which complicates the development of standard technology. In industry, production technology is formalized and documented. The diverse nature of the constructed objects requires a different spatial division of the front of work (7) to combine the production of work and reduce the duration of construction. In construction, as in no other branch of industrial production, the influence of natural factors is great (8). The listed construction features increase the probabilistic nature of the system, make its behavior less predictable, and complicate the entire construction production management system, including the construction and planning process. In industrial enterprises, which are characterized by the stability and frequent repeatability of homogeneous control processes, where the technological process of production is clearly worked out, normalized and documented, the control system is based on the "control process model".

3. Project Technological Dependencies Model (PTDM)

In construction, the existing documentation on the technological preparation of production is not the basis of the entire workflow. Therefore, the basis of the control system is the "model of the control object", which implements the requirements presented to a particular object and the purpose of its functioning and allows you to create a management process that meets them. Such a model are the calendar schedules for the construction of the facility and are included in the list of documents of a Construction Production Plan (CPP) and a Construction Execution Plan (CEP). Building construction schedules are displayed in the form of linear models, network schedule and cyclic graphs. They belong to the class of organizational technological model (OTM), which reflect the organization of construction production and the technological sequence of work. On the basis of construction schedules, the tasks of planning construction and installation work in time, providing material and technical resources, accounting and monitoring the progress of construction production and others are being solved. During the project, under the influence of various factors, the construction industry deviates from the planned one and the construction schedules need to be adjusted. A workflow mismatch is formed between the construction progress and the logistics of building resources for the facility. To increase the compliance of the workflow, it is necessary to increase the stability of the basic management model. Studies [11, 12] emphasize that existing technologies of information modeling allow specialists of different profiles to see and control all changes occurring in the model. These changes occur using information that is presented in digital form, which allows you to work with emerging changes quite quickly.

However, it should be noted that instead of construction schedules, a model is needed that describes the construction technology of the facility. Such a model is less susceptible to the effects of various destabilizing factors. The peculiarity of such a model is the presence of quantitative assessments of technological interrelations between the works (more details in [4]). The Project Technological Dependencies Model (PTDM) allows us to solve not only the control problems listed above. It dates the ability to determine the technologically possible minimum duration of the construction of the facility.

The Project Technological Dependencies Model is described by the following parameters:

1. Technological dependencies of construction works: "not earlier than the initial one" and "not earlier than the final one".

2. Temporary range of the work (not to be confused with the duration of the work).

3. An overall duration of a project, directive (normative) duration.

4. Criticality points for each construction works (the maximal amount of manpower that can be used in construction an object).

Conclusions

In the process of trial operation of software in a construction organization, difficulties in the formation of information support were revealed. Since such parameters will not be included in multi-parameter models of existing information models. Difficulties concerned the determination of quantitative estimates of the technological interconnections between jobs, which are set by the minimum volumes at the beginning and at the end of each work. There were also difficulties in determining the critical points of work, since it was necessary to know and set the maximum amount of resources such as power. In the future, this allows us to determine the minimum possible duration of each work and the production of a complex of works at the facility.

The intensive development of information modeling in construction allows us to resolve the lack of information support. With the help of 3D-modeling, the level of automation increases not only when developing a basic model for managing construction production, but also building management as a whole.

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ТЕХНОЛОГИЯ ИНФОРМАЦИОННОГО МОДЕЛИРОВАНИЯ КАК ОСНОВА АВТОМАТИЗАЦИИ УПРАВЛЕНИЯ СТРОИТЕЛЬНОЙ ОРГАНИЗАЦИЕЙ

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Определено два информационных барьера, которые повлияли на явление «управление организацией» как процесс. В результате первого барьера появилась необходимость разграничения функций управления по отдельным лицам. Второй барьер послужил толчком для внедрения автоматизации в управление организацией. Первоначально автоматизация касалась только решения локальных задач. Со временем автоматизированные системы управления позволили интегрировать деятельность всей организации. Технологии информационного моделирования в строительстве (BIM) в настоящее время позволяют учитывать разросшийся поток данных о строительных объектах на всех стадиях жизненного цикла объекта строительства. Существуют значительные отличия строительного процесса, которые должны отражаться в информационных системах: неподвижность продукции, территориальная разобщенность конечной продукции, длительность производственного цикла, многообразие и взаимозаменяемость потребляемых ресурсов, многовариантность технологических решений, трудность разработки типовой технологии, сложность совмещения работ, влияние природных факторов. В основе управления в строительстве лежит «модель объекта управления». Одним из элементов данной базовой модели является модель технологических объектных зависимостей (МОТЗ). Данная модель позволяет повысить надежность принимаемых управленческих решений. В основе модели лежат количественные оценки технологических взаимосвязей между работами.

Ключевые слова: модель технологических объектных зависимостей, МОТЗ, информационные барьеры в управлении, технологии информационного моделирования в строительстве, BIM, автоматизированные системы управления, особенности строительного производства.

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